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The Influence of the Goshgarian Palatal Bar on the Anterior-posterior Positioning of the Tongue

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THE INFLUENCE OF THE GOSHGARIAN PALATAL BAR ON THE ANTERIOR-POSTERIOR POSITIONING OF THE TONGUE

By

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I am very grateful to my parents for their love, guidance and support throughout my life.

Finally, I would like to express my deepest gratitude to my lovely wife, Susan, who has been an endless source of comfort and encouragement during the many long years of education, and who has blessed me with a beautiful son, Brian.

AUTOBIOGRAPHY

Mark Jeffrey Weisenberg was born in Los Angeles, California on March 12, 1948. He was the second of three children with an older brother Gary, and a younger sister Karen.

Mark graduated from University High School in Los Angeles in 1966.

He enrolled at the University of California at Los Angeles and received his Bachelor of Arts degree in June, 1970.

In the Fall of 1970, Mark began studies at Loyola University School of Dentistry in Maywood, Illinois. He received his Doctor of Dental Surgery degree in June, 1974.

In July of 1974, Mark continued his studies into Oral Biology and Orthodontics at Loyola.

Mark was married on July 4, 1971 to Susan Moldovan; they presently have one son.

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INTRODUCTORY REMARKS AND STATEMENT OF THE PROBLEM

The Goshgarian palatal bar is an innovative therapeutic instrument available to the orthodontist to orthopedically control vertical dimension growth. This particular function of the palatal bar has special significance for patients exhibiting a high mandibular plane to cranial base angle.

The purpose of this study was to determine to what extent the tongue is influenced by a decrease in tongue space. Specifically, does the use of the palatal bar cause an increase or decrease in anterior tongue pressure? Moreover, does the tongue accommodate to the reduced oral space by repositioning itself anteriorly or posteriorly as measured by a change in hyoid bone position?

Two basic techniques were used to perform this study.

A. A myometric study was done to measure the force of the tongue during normal swallowing without the palatal bar. The force was again measured after 7 days of palatal bar wear.

B. Cinefluorographic sequences of deglutition were taken before insertion of the palatal bar, and again after 7 days of palatal bar wear.

A. Tongue Anatomy

The tongue is composed of two parts, an anterior two thirds and a posterior one third, which differ developmentally, structurally, in nerve supply and in appearance.

Woodburne (1973) describes the tongue as a highly mobile, muscular organ vital to the digestive functions of mastication, taste, and deglutition. It is also important to speech. The mobility of the tongue is enhanced by its suspension from three well-separated bilateral attachments: the mandible, the styloid process of the temporal bone, and the hyoid bone. From these bony attachments, the three principal extrinsic muscles of the tongue (genioglossus, styloglossus, and hyoglossus) enter the tongue to spread out into its substance. The muscular meshwork of the tongue is also contributed to by its intrinsic muscles, i.e. superior longitudinal, inferior longitudinal, transverse and vertical. The entire dorsum of the tongue is covered by a mucous membrane containing papillae of various forms, taste buds, and the lingual tonsil.

The simpler movements of the tongue may be analyzed on the basis of the traction of the various muscles. The middle and inferior parts of the genioglossus are primarily concerned in protusion of the tongue. The superior fibers of this muscle draw the tip back and down in the mouth. The styloglossus muscle retracts and elevates the whole tongue. The hyoglossus muscles flatten the tongue and draw down its sides. The intrinsic muscles assist in the various actions mentioned and are especially concerned in deviation of the tongue to the side.

B. Studies on Tongue Position and Tongue Pressure

In 1873, Tomes postulated that tooth position was determined by an equilibrium of forces between the tongue and perioral musculature. In the past 20 years, this long accepted theory has come under close scrutiny.

Kydd, in 1956, devised a method for recording lateral and anterior forces exerted by the tongue. By utilizing denture blocks affixed with electric resistance strain gauges, he determined the anterior tongue pressure on the mandibular incisors of one patient to be 5.2 pounds.

Winders, (1956, 1958) used resistance strain gauges in the construction of a transducer element. He found that there was an apparent imbalance of muscular forces acting on the dentition between the lingual and buccal sides, with the greater force being exerted by the tongue.

In an attempt to elucidate further on his previous work, Kydd (1957) studied the maximum tongue pressure against the upper anterior teeth. He also showed that the pressures exerted by the tongue were greater than those exerted by the lips.

Lending support to the century old hypothesis that normal occlusion was due to an equilibrium of tongue and cheek forces, Straub (1961) claimed an abnormal swallowing habit is definitely one of the causes of some severe Class III malocclusions. He contended that an abnormal swallowing caused a complete collapse of the maxilla, and adverse growth of the mandible resulted from the masticating pressure of a complete cross-bite on the upper jaw. He further stated the child who has not learned to swallow properly has never put his tongue against his palate; and as a result, the palate remains so narrow that it is mechanically impossible to place the tongue against it.

Gould and Pecton (1962) studied forces on the teeth from the tongue and perioral musculature. They found the pressure transducers should be no more than 2 mm from the surface of the tooth, or the force would be greater than normal.

Through further refinements of his earlier work, Kydd (1962) used pressure transducers with strain gauges mounted on Hawley type retainers to measure the pressures exerted by the tongue during swallowing. Specifically, he recorded pressure in the anterior, lateral, and central palatal areas. He concluded that, in general, swallowing pressures were greater in the anterior and lateral palatal areas than in the central palatal areas. He pointed out that subjects with peaked palates tended to have more pressures in the lateral palatal area than subjects with round or flat palates.

Carrying this concept a step further, Backlund (1963) showed a correlation between tongue posture and upper jaw width. He contended that the upper jaw determines tongue position. Those patients with narrow jaws showed an increased frequency of very low tongue postures, while patients with broad upper jaws showed an increased frequency of higher tongue postures. He explained it is conceivable that a primary effect of the narrow upper jaw, was to make it difficult for the tongue to adapt to the palate, partly because of the actual shape of the jaw and partly because of breathing habits. Additionally, he pointed out that tongue posture showed no significant correlation with the width of the lower dental arch; jaw height, or inclination of the lower incisor. He concluded that if tongue posture affected the width of the upper jaw, then one would expect different postures to affect the lower jaw. This does not turn out to be the case.

Weinstein, in 1963, also studied the theory of equilibrium as it applies to the elements of the dentition. His conclusions were: 1) Forces exerted upon the crown of the tooth by the surrounding soft tissue may be sufficient to cause tooth movement in the same manner as that produced by orthodontic appliances. 2) Each element of the dentition may have more than one position of stable equilibrium within the system composed of the natural oral environment. 3) Differential forces, even when they are of small magnitude, if applied over a considerable period of time, can cause important changes in tooth position.

In studies relevent to prosthetic dentistry, Murphy (1967) pointed out that the rest position of the mandible is related to the posture of the tongue as a result of its respiratory function as part of the anterior wall of the pharynx. He explained dentures could trigger a posterior repositioning of the tongue and therefore create a decreased lumen of the airway. However, by a downward movement of the mandible, the volume of the oral cavity is increased sufficiently to accommodate the tongue without its encroaching on the airway.

In a study of tongue dimensions, Hopkins (1967) measured 32 meonatal and 30 adult tongues postmortem. He showed that the length doubles between birth and adulthood.

Proffit in 1969, used strain gauge pressure transducers to study linguopalatal pressures. He found that peak lingual pressures during swallowing ranged from 50 to 400 Gm/cm^2. Additionally, his results showed each individual tended to reproduce his own pressure levels and the pattern of swallowing activity was consistent for each individual. The tongue activity during swallowing was also found not to be strongly related to maxillary width. A narrow maxilla exhibited high lingual pressures and low buccal pressures. Thus, the arches did not assume harmonious balance with muscle pressures. He concluded the factors which do control the arch width appear to operate independently of any lingual pressures.

Lear and Moorees (1969), measured buccolingual muscle force and dental arch form. Their experimentally derived estimates of the muscle forces falling on the arches did not, in general, bear out the assumption that dental arch form directly reflects the influence of the surrounding buccolingual musculature.

Bandy (1969) also attempted to correlate tongue size to tooth position by measuring the tongue volume of the anterior portion of the tongue. He concluded that there was no close relationship between tongue volume and lower arch dimension, incisor angulation, or tongue length.

Proffit, in 1972, conducted a longitudinal study of the lingual pressure patterns of 10 children whose swallow type changed from "tongue thrust" to "adult". His data supported a gradual transition toward adult swallowing. The transition period extends beyond the time at which a changed pattern is detected clinically, to include a period of accommodation to containment of the tongue. Clinically troublesome tongue thrust swallows, he claimed, are delayed intermediate stages in the normal transition; not habits in the usual sense.

In an effort to correlate functional lingual pressure and oral cavity size, McGlone and Proffit (1972) studied nine children with oral cavities varying greatly in size. The results suggested functional activities contributed only to a limited extent to overall growth of the oral cavity. They speak of a "semifunctional matrix", meaning that resting, longer acting forces were more significant to arch formation, than were intermittent intense forces like swallowing or speaking.

Posen (1972) evaluated the influence of maximum perioral and tongue force on the incisor teeth. Maximum tongue strength was shown to range from 600 to 2500 grams. There was a significant relationship between maximum strength and force of the lips, and the final position and angulation of the maxillary and mandibular incisor teeth, but not a significant relationship between tongue force and incisor position. This study indicated that the role of the tongue in determining final incisor position was minimal except in abnormal swallowing or abnormal positioning at rest.

Wallen (1974), also using pressure transducers, found that individuals with normal occlusion had higher pressures in the vertical and intermediate than horizontal planes of space. Those subjects with open bites, in contrast, had approximately equal pressures in all planes. Vertically directed pressures in the subjects with open bite were significantly lower than normal. He claimed that the clinically observed differences in swallowing in individuals with anterior open bite reflected the presence of malocclusion; altered swallowing gestures have not created this malocclusion.

Proffit, in 1975, compared the tongue pressures of Australian Aborigines to those of American Whites. His results indicated that the muscular activity of the lips does not seem to balance the functional activity of the tongue. He concluded that the form of the dental arches dictated the functional pattern of tongue and lips to a much greater extent than function altered form. To the extent that the form of the dental arch is influenced by musculature, it appeared that the resting pressures and posture were more dominant than active swallowing or speech.

C. Cephalometric and Cinefluorographic Literature

An additional aid in the study of tongue pressure and positioning is the cinefluorograph which was first used by Saunders, Davis and Miller (1951) to study deglutition. They were able to ascertain from x-ray motion pictures that normal human deglutition involved essentially an initial rise of the larynx, a vigorous backward thrust of the base of the tongue, followed by a wave of pharyngeal sonstrictor muscle contraction.

Shelton, Bosma, and Sheets, in 1960, also used the Cinefluorograph to describe the interrelation of the tongue, hyoid and larynx in swallowing and phonotion.

Subtelny (1965) again cited cinefluorography as a tool to study swallowing behavior. He described the initial act of swallowing as "toothpaste being pressed from a tube."

In 1965, Stepovich described a technique using cephalometrics to measure the hyoid bone in three positions - - vertically, horizontally and angularly. The author pointed out the necessity of eliminating all movements of the head since the hyoid is completely suspended by muscle and must be related to a fixed point. All of the author's attempts for reproducible measurements failed and hyoid movement occurred.

Also using cinefluorography, Cleall (1965) showed that under standardized conditions, individuals do have characteristic and reproducible oropharyngeal resting postures and movement patterns during swallowing. There was, however, a wide spectrum of activity between individuals. Additionally, he studied the adaptability of the tongue to a restricting crib. The crib appeared to basket the tongue and cause it to function in a more posterior and higher position. He determined that restricting the anterior part of the tongue initiated compensatory changes, so that the hyoid bone was found to be in a posterior position at rest and in function.

Sloan, in 1967, evaluated the use of Cephalometric-Cinefluorographic techniques in the assessment of hyoid behavior during deglutition. He studied patients having Class I malocclusions, Class II, Division 1 malocclusions and Class II, Division 2 malocclusions. He found that the patients with Class I malocclusions showed significantly lower and more posterior hyoid positions (relative to the mandible) complimented by limited functional patterns. The Class II malocclusions, on the other hand, showed higher and more forward hyoid postures (relative to the mandible) with greater ranges of movement during deglutition.

Conversely, Cookson (1967) using lateral cephalometric head plates, measured the rest position of the tongue. He found that there was a general lack of correlation of tongue resting position to age, sex, skeletal patterns, occlusion and incidence of thumb sucking.

This lack of correlation, he suggested tends to confirm that tongue position is dictated by environment and afferent stimuli from that environment.

Peat (1968) in a Cephalometric study of tongue position, described two postural positions for the tongue. The first is a habitual postural position where the muscles are actively positioning the tongue. This position is reproducible and characteristic for the individual. The second is a relaxed postural position of the tongue which is non-reproducible.

In an attempt to correlate the size of the tongue to the intermaxillary space, Vig (1974) devised a method for measuring this ratio. He compared a sample of children (mean age equal to 9.9 years) to adults (mean age equal to 28.2 years), and found the tongue tended to become relatively smaller when compared to intermaxillary space. Vig explained this partly by the differential rates of maturation of the skeletodental and muscular elements, and partly by the descent of the tongue and associated structures which occurs with growth of the cervical spine.

Cuozzo, in 1973, tried to determine if the hyoid bone position could be changed to accommodate forced distal positioning of the tongue. His sample of

Class I "normal" occlusions was studied by cinefluorography and myometric analysis. The results indicated that the tongue could adapt within certain anatomic limits.

Gobeille (1974) repeated the study of Cuozzo using open bite tongue thrust subjects. In general, his results supported the earlier work by Cuozzo.

MATERIALS AND METHODS

I. Selection of Subjects

Twelve subjects were selected through diagnosis of new patients to be started in active treatment in the orthodontic clinic. Eight of the subjects were male and four were female. They ranged in age from 10 to 15 years. All subjects had a Mandibular Plane Angle (NS-GoGn) of 40 degrees or more, (as determined from lateral cephalometric headplates) but their respective malocclusions varied.

II. General Description of Procedures in Order:

1. The maxillary right and left first molars of each patient were banded with orthodontic bands.
2. Cinefluorographic sequences of normal deglutition were taken.
3. A myometric analysis of tongue pressure was done.
4. A Goshgarian palatal bar was adjusted to fit passively between the maxillary molars and placed in the subjects mouth.
5. After one week of palatal bar wear, another cinefluorographic sequence of deglutition was taken with the bar still in place.

6. Seven days from palatal bar insertion a second myometric analysis of tongue pressure was taken.

III. Palatal Bar Placement Details

Each subject was fitted with orthodontic bands for the maxillary first molars. The bands had .036 x .072 inch rectangular sheaths prewelded to the lingual surface of each band. The bands were cemented to the maxillary first molars. A preformed Goshgarian palatal bar was adapted to fit passively between these molars. The U-shaped end portions of the palatal bar were fitted into the lingual sheaths to retain the bar in position in the mouth.

Since all subjects had a high mandibular plane angle, the palatal bars were adapted to fit lower in the vault than usual. This was evidenced by a less severe curvature to the bar than would normally be incorporated. The distance from the hard palate was a clinical judgment based on the depth and morphology of the vault.

IV. Hyoid Rest Position Recorded by Cinefluorography

The equipment used was a Picker Cinefluorograph with an image intensifier and a Vanguard Motion Analyzer for evaluation of the films.

The cinefluorograph consists of an x-ray head with a lead plate columnator and image intensifier with a motion picture camera and optical system mounted on a "C" arm which is fully adjustable in a vertical direction. There is a head holder at a fixed distance between the x-ray source and the camera.

The subjects were placed in a chair of fixed height for each recording. Their heads were stabilized by ear rods from the head holder and they were oriented so that the Frankfort Horizontal Plane was parallel to the floor.

The films were shot at 60 frames per second for approximately seven seconds and were recorded on 16 mm Kodak Shellburst film. The x-ray control was set for 90 kilovolt peak and 13 milliamperes which seemed to provide the best picture. The total radiation received by each subject was approximately .35 R.

Each subject was given approximately 4 cc of barium sulfate to swallow at each sitting. They were instructed to hold the barium in their mouths until the camera was started and two swallows were recorded at each sitting.

The 16 mm films were processed on a Profexray automatic film developing machine and then examined on a Vanguard Motion Analyzer. Accuracy of this equipment was quite sufficient to analyze the films with good results. The speed of the motion analyzer was adjusted from 5 to 30 frames per second and individual frame viewing was also possible.

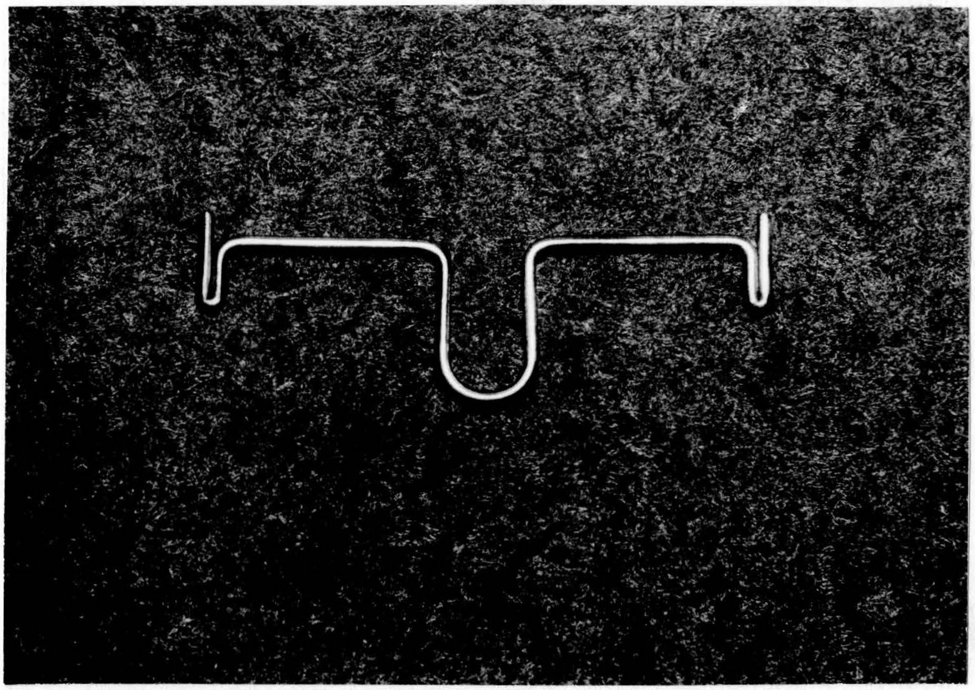
Tracings of each subject were made on acetate paper placed on the screen of the Analyzer. The "rest position" of the hyoid bone, the mandibular symphysis, lower border of the mandibular body, the maxillary central incisor and the A-P plane of the maxilla (anterior nasal spine to posterior nasal spine) were recorded. The change in hyoid position was obtained by superimposing before and after tracings. The maxillary incisor and the respective A-P planes were used as reference landmarks.

V. <u>Myometric Measurement of Tongue Pressure</u>

To measure the force of the tongue during swallowing a small rectangular metal plate (2 mm x 3mm) was placed approximately 2 mm lingual to the incisive papilla. A one inch length of .014 gauge wire was soldered perpendicularly to the labial side of the plate. A ¼ inch piece of .036 gauge wire was soldered to the end of the .014 wire. The .036 wire attached to a female socket which was soldered to an extension arm of the pressure transducer. The pressure transducer was a Myograph C manufactured by Narco-Bio Systems with a range from 0-500 grams and a maximum sensitivity of 1 centimeter deflection for 5 grams of force. The pressure transducer recorded on the graph paper of a polygraph (Physiograph Narco Instrument Company) by pen deflections. Calibration was done following each writing by using standard 10, 20, 30, and 50 gram weights hung from the transducer.

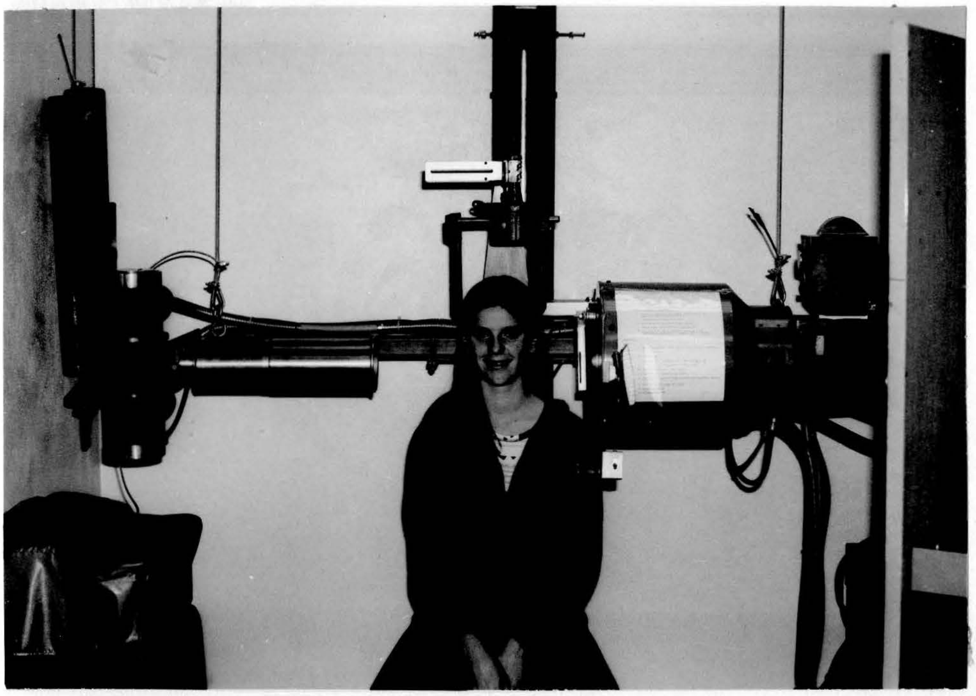
Each subject was seated and his head stabilized by the head rest of the dental chair. Water was repeatedly introduced to the subject's mouth by means of an eye dropper and the subject's swallows were recorded. Every effort was made to reproduce experimental conditions for each subject at each of the recordings.

Fifteen to thirty swallows were recorded at each of the two sittings. The amplitudes of the pen deflections were measured in millimeters and converted to grams following calibration with a given standard force. The most representative swallow patterns were selected. These forces were combined to give an average.

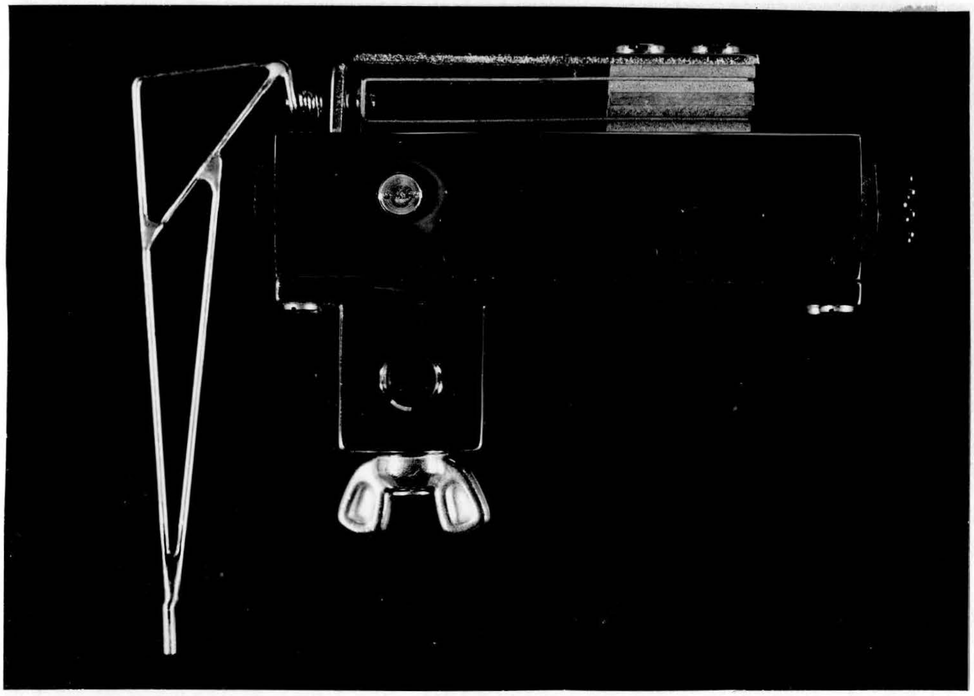


Preformed Goshgarian Palatal Bar

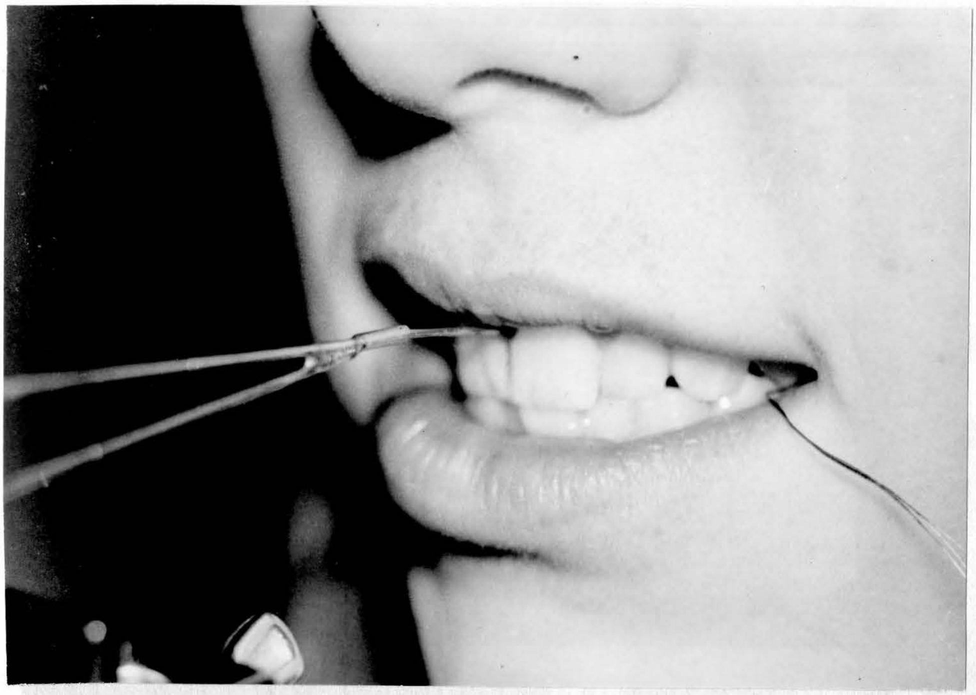
Palatal Bar Adapted and Placed in Subject's Mouth



Subject seated in Picker Cinefluorograph



Myograph C Pressure Transducer

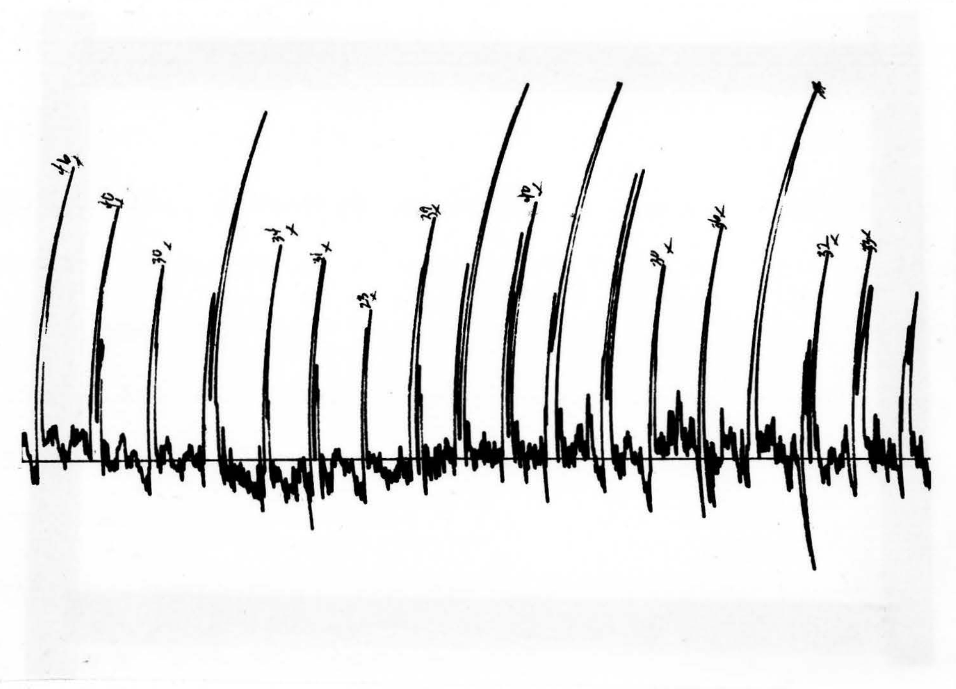


Pressure Transducer Extension Arm - Front View

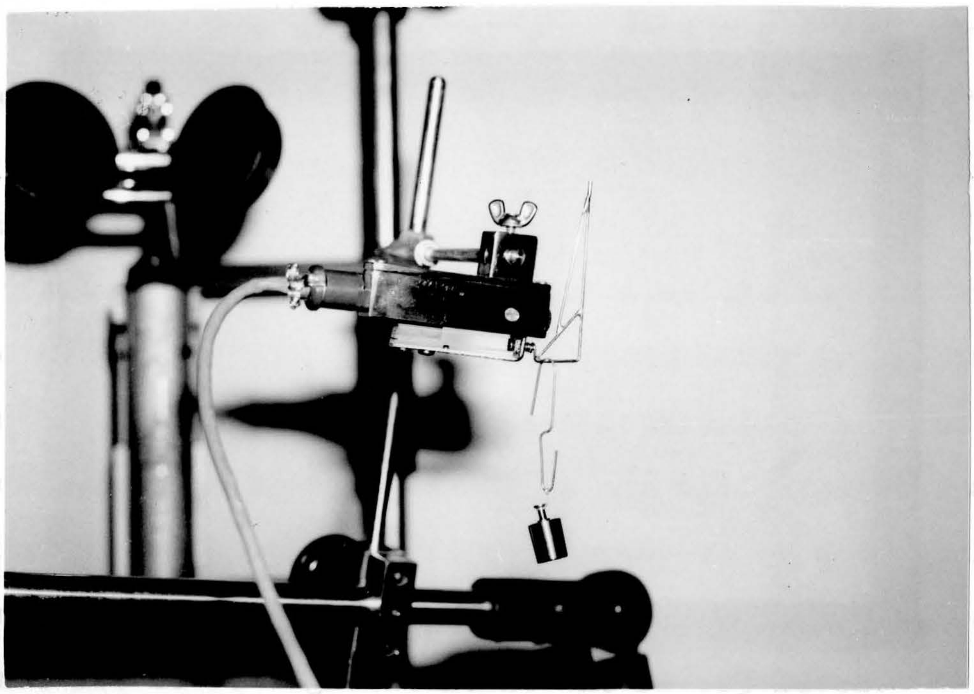
Pressure Transducer Recording Plate Lingual View

Stabilization of Subject's Head

Introduction of Water to Subject's Mouth



Sample Myograph Recordings on Physiograph



Calibration of Myograph with Known Force

RESULTS

The results of the myometric measurements on the physiograph are presented in Table I. Each subject is identified in the first column by initials. The recordings of tongue pressure during normal deglutition before the palatal bar was placed are presented in column two. The third column shows tongue pressures after one week of palatal bar wear.

Table II presents the measuring results for the change in the rest position of the hyoid bone. The rest position was defined as the most posterior and inferior position before deglutition.

It is readily seen in Table I, that the first seven subjects appear to exhibit a decrease in tongue pressures while the last five appear to show an increase in tongue pressures.

However, one would have to question the significance of the amounts of change. In most cases, they are certainly within experimental error. Since approximately half of the subjects showed a decrease in force and half exhibited an increase in force, there does not appear to be a trend in change. A Pairedttest of these results shows the changes in force not to be significant at the P= .05 level.

The results of Table II also bear examination. On the basis of the equipment and technique used, any change in hyoid position of 2 mm or less is probably insignificant. Half of the subjects exhibited no change in hyoid position and half showed some type of hyoid accommodation.

The total effect of the bar on the tongue, when examined by both methods, appears to be minimal.

TABLE I

AVERAGE MAXIMUM TONGUE PRESSURE AGAINST TRANSDUCERS DURING SWALLOWING AS RECORDED ON THE PHYSIOGRAPH (GRAMS)

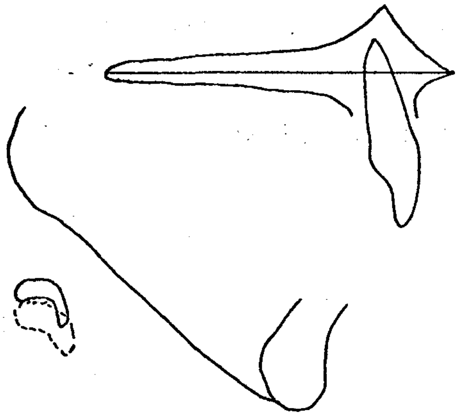
	Subject	Before Palatal Bar Placement	Seven Days After Insertion of Palatal Bar
1.	D.C.	32.8	27.6
2.	B.B.	27.3	12.7
3.	P.Z.	18.0	15.9
4.	R.L.	16.8	11.8
5.	C.D.	11.1	7.8
6.	R.S.	32.2	23.0
7.	J.B.	123.3	113.9
8.	R.G.	35.4	43.7
9.	J.Z.	18.4	24.8
10.	C.M.	18.2	41.3
11.	S.D.	19.7	33.7
12.	D.G.	14.4	22.9

TABLE II

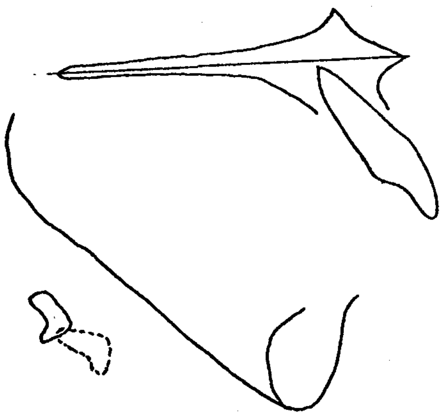
CHANGES IN HYOID BONE POSITION AS RECORDED FROM CINEFLUOROGRAPHIC TRACINGS

1.	D.C.	Inferiorly 3 mm
2.	B.B.	Inferiorly 4 mm; Anteriorly 5 mm
3.	P.Z.	Anteriorly 2 mm
4.	R.L.	Inferiorly 1.5 mm; Anteriorly 4 mm
5.	C.D.	No change
6.	R.S.	Inferiorly 3 mm; Posteriorly 6 mm
7.	J.B.	Inferiorly 5 mm; Anteriorly 10 mm
8.	R.G.	No change
9.	J.Z.	Superiorly 1 mm
10.	C.M.	Anteriorly 2 mm
11.	S.D.	Anteriorly 2 mm
12.	D.G.	Posteriorly 4 mm

D$\bar{C}$



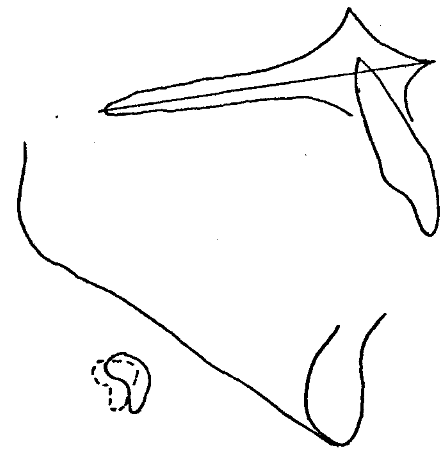
BB1



 - Hyoid position before palatal bar placement

 - Hyoid position after 7 days of palatal bar wear

PZ



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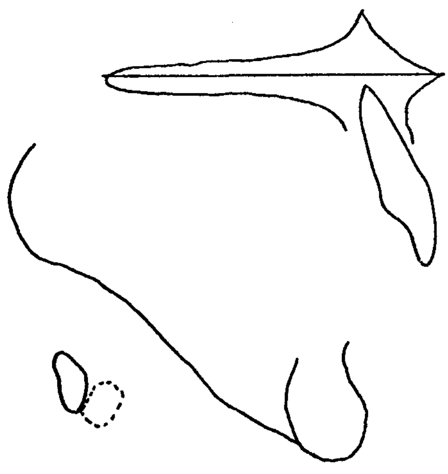
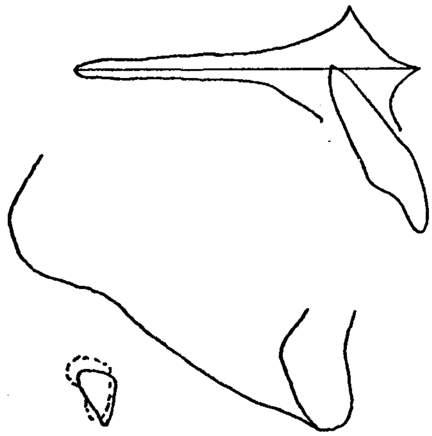


CD



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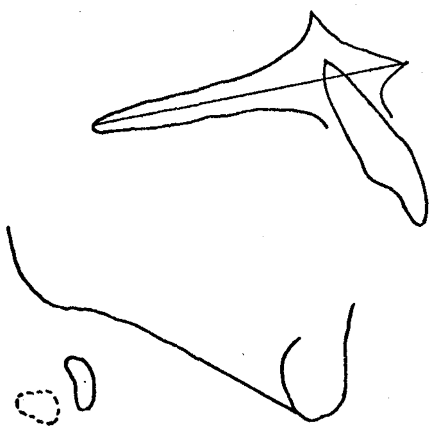

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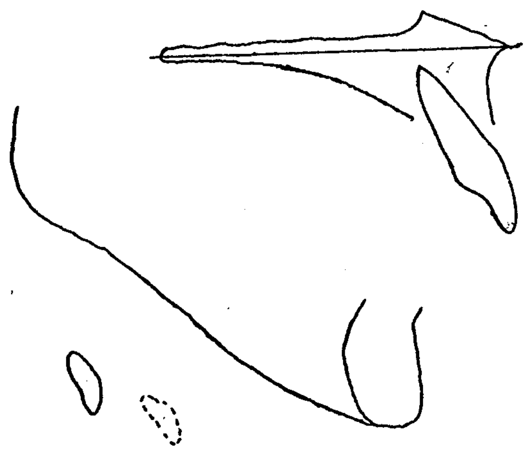

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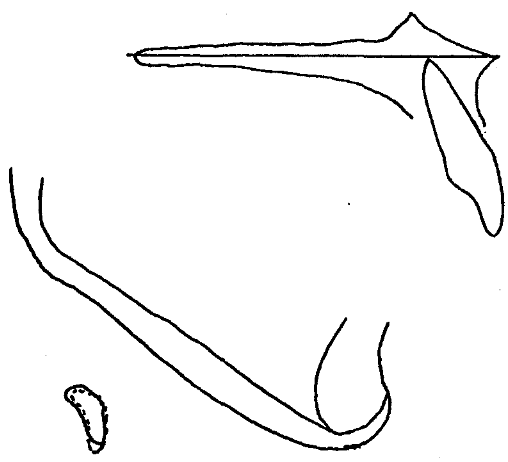

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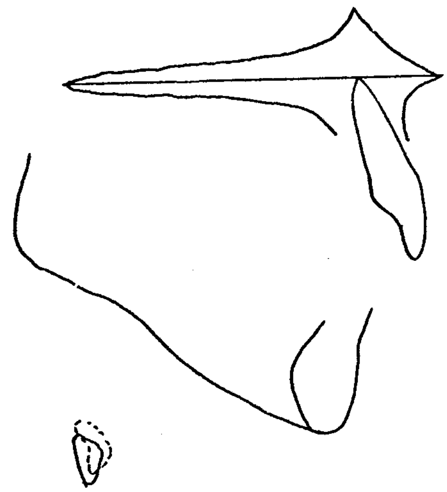

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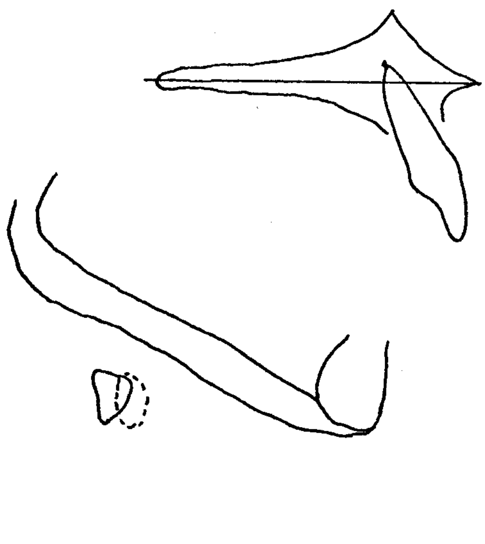
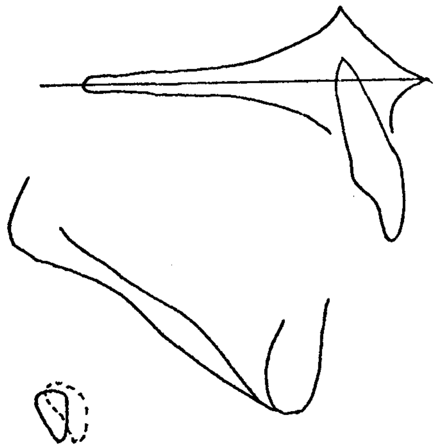
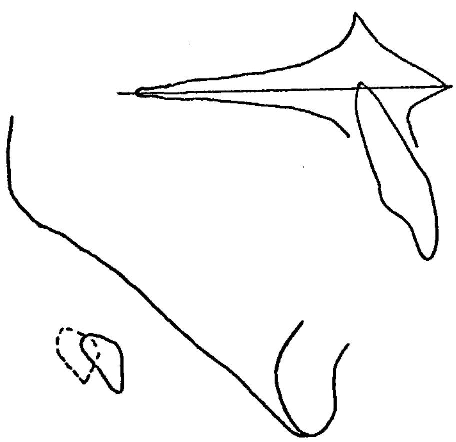


SD



DG



DISCUSSION

This study attempted to determine to what extent the Goshgarian palatal bar influences the tongue when used on patients exhibiting a high mandibular plane to cranial base angle. The technique used, described originally by Cuozzo (1973) and Gobeille (1974), includes myometric readings of tongue pressure, and cinefluorographic film sequences of normal deglutition.

Analysis of the myometric results would seem to indicate that the palatal bar did not cause a change in anterior tongue pressure. The actual changes in the relative force values can most probably be attributed to experimental error. However, if the percentage change seen in some of the subjects actually is significant, then it would have to be assumed that there was an attempt on the part of these subjects to accommodate to the bar. This accommodation should be explained by the effect on hyoid bone position.

Cuozzo (1973) indicated that the hyoid bone could not reposition beyond the limits of the stylohyoid ligament which suspends the hyoid from the skull. Therefore, he concluded that the bone had to accommodate to a new position on an arc formed by this ligament.

He further reported that those subjects who held the hyoid bone close to the lower border of the mandible, showed the ability to move the hyoid bone posteriorly and inferiorly. Those subjects whose hyoid bone was further from the mandibular plane were unable to reposition the hyoid bone in this fashion.

The first subject of this study to exhibit any significant percentage decrease of force (53%) was B.B. Her hyoid repositioning, however, was inferiorly and anteriorly, and therefore not consistent with a change which would reflect decrease tongue pressures.

C.M. demonstrated an increased pressure of 55%. In this case however, the anterior repositioning of the hyoid would be consistent with an increased pressure.

S.D. also showed an increase of pressure in the range of 40%. Again the hyoid bone was repositioned anteriorly, and an increase of pressure would be expected.

Subject J.B. exhibited a minimal decrease in tongue pressure and yet the change in hyoid position was the most severe. This may be explained, in part by the fact that this subject revealed an abnormal swallowing pattern at the start of the investigation. The tongue appeared to be squeezed against the palate twice before the involuntary stage of swallowing was initiated. Perhaps severe hyoid adaptation was required in this case to maintain the swallowing pattern.

R. S. was the only subject whose hyoid readapted posteriorly and inferiorly as was reported by Cuozzo and Gobeille. However, the change in relative tongue pressure was only 28%, and therefore probably not significant.

If one examines the results for P.Z., R.L., C.D., and D.G. again it appears that the pressure changes do not necessarily correlate to the hyoid bone changes.

The relatively small changes which occurred in tongue pressures and the variation in hyoid repositioning strongly suggest that the Goshgarian palatal bar has only a negligible influence on the position of the tongue.

In the studies by Cuozzo and Gobeille, the respective appliance under scrutiny was a tongue crib specifically designed to force the tongue distally. The Goshgarian palatal bar, although designed to attract the tongue, in no way exhibited the restrictive capacity of a tongue crib. Despite the fact the tongue space is reduced by the palatal bar, it would appear that this encroachment on the tongue is insufficient to alter the usual tongue positioning pattern for a given individual. As a matter of interest, each subject was questioned at the second sitting as to how much the palatal bar had bothered him.

All of the subjects replied that the bar was only troublesome for a day or two. After that time, the bar was unnoticed or at least presented no further difficulty to talking or deglutition. This latter information, coupled with the results of the hyoid measurements would tend to suggest that if any adaptation was necessary, it was probably on the part of the intrinsic musculature of the tongue. The extrinsic musculature in most of the cases may not even have been affected.

In the works of Cuozzo and Gobeille, a linear measurement was made from the mandibular border to the resting hyoid position. This technique was not used in this study because it was felt this measurement was not a part of any standard diagnostic orthodontic evaluation. The clinical application of the palatal bar has not been previously restricted by hyoid position. On the other hand, had the results indicated a significant change in tongue position with the palatal bar in place, it might have been wise to return to the original cephalometric head plates to correlate hyoid position to the mandible.

Stepovich (1965) felt accurate measurement of the hyoid position was extremely difficult, if not impossible, with the cinefluorographic technique because of head movement. Cuozzo and Gobeille used a support stand for the mandible to maintain and reproduce head posture during the cinefluorograph sequences. In this study, it was observed many of the subjects included a movement of the mandible during swallowing particularly when the teeth were not in a position as swallowing began. This was described by Subtelny (1965). Proffit (1972) explained the transitional period in swallowing included more tooth contact with maturity. The use of a support stand for the subjects in this study may have introduced an additional variable requiring accommodation.

The subjects in this study did not appear to be influenced by the palatal bar. Therefore, one can only speculate as to the overall adaptability of subjects in this age group. It is well known that younger individuals are more adaptable biologically and physiologically than older individuals. If the palatal bar actually did elicit an adaptational response, it was indeed well masked by maintaining the usual tongue pressure for each individual. Had an adult group of patients been selected, perhaps the results might have indicated a more direct influence on the tongue. A number of variables interact during the entire biological adaptation period. The subjects neurological patterns and proprioceptive feedback mechanisms are of paramount importance, and thus far, the cycles of deglutition remain somewhat incomprehensive.

A study of this nature supplies limited information. The variables in such an investigation are many, and therefore leave numerous other questions unanswered. For example, what kinds of changes in pressure, if any, take place during the first 24 to 48 hours? Does the hyoid bone show any adaptation during these first two days? How low in the vault can the palatal bar be positioned before it becomes restricting enough to effect a change in tongue position? It is hoped that these questions will stimulate further investigation. There is still much to learn about the procedures and changes effected by orthodontics.

SUMMARY & CONCLUSIONS

This study was performed to determine to what extent the tongue is influenced by the Goshgarian palatal bar. Specifically, does a decrease in tongue space cause a change in the anterior posterior positioning of the tongue?

Twelve subjects were selected, all of whom demonstrated a Mandibular plane to cranial base angle of 40 degrees or more, as determined by a lateral cephalometric head plate.

The Sequence of Procedures were as follows:

1. The maxillary right and left first molars of each patient were banded with orthodontic bands.
2. Cinefluorographic sequences of normal deglutition were taken.
3. A Myometric Analysis of tongue pressure was performed.
4. A Goshgarian palatal bar was adjusted to fit passively between the maxillary molars and placed in the subjects mouth.
5. After one week of palatal bar wear, another cinefluorographic sequence of deglutition was taken with the bar still in place.

6. One week subsequent to palatal insertion a myometric analysis of tongue pressure was taken.

Examination of the myometric results indicated the tongue pressure in this study did not change. Further analysis with cinefluorographic sequences showed either no changes, or changes that would be inconclusive with the myometric results. It is concluded from this data the anterior-posterior positioning of the tongue was not significantly affected by the Goshgarian palatal bar. A comprehensive neuromuscular explanation of the effects of the bar upon deglutition became singularly elusive and exceeded the scope of this study.

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The final copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the thesis is now given final approval by the committee with reference to content and form.

The thesis is therefore accepted in partial fulfillment of the requirements for the degree of Master in Oral Biology.

5/12/76
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